Study of the top quark pairs production collected by the ATLAS detector at the LHC collider

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In nominal conditions the LHC will collide proton beams of 7 TeV producing one top quark each second. I introduce the interest of the top quark physics and an improved procedure for the mass reconstruction in the semileptonic channel developed on Monte Carlo simulations. I show the interest of multivariate analysis for the jet selection.

1 Interest of Top quark physics

Because of its high mass the top quark is an important milestone to understand Particle Physics. The measurement of its parameters will allow to test the precision of the standard model. The precise measurement if its mass coupled to the one of the W boson will constrain the Higgs boson mass.
Being the heaviest particle discovered it is also a privileged partner for New Physics particles and for the same reason the main background for their search. The precise reconstruction of the Top quark is then a key point for these measurements. In our study we focus on the jet selection for the hadronic top quark.

2 Jet selection in $t\bar{t} \rightarrow e\nu b\bar{b}q\bar{q}$ and $t\bar{t} \rightarrow \mu\nu b\bar{b}q\bar{q}$

At the LHC top quarks will be predominantly produced in pairs due to quarks or gluons fusion. The most promising desintegration channel for our study is the semileptonic one which has a branching ratio about 30%. With only one neutrino, one lepton and four jets in the final state, it is a good compromise between signal efficiency and background level.
We focus on the hadronic top quark reconstruction. Giving three jets in the final state, the issue is to select the jets trully coming from the hadronic top with the best efficiency.

2.1 Geometrical based analysis

The procedure [1] is to select the jets by topological proximity [a]. The two jets emitted by the W boson are chosen as the two closest in ΔR. When the W boson is reconstructed, the closest jet in ΔR is selected as being the one coming from the b quark. We can then reconstruct the top quark with a good efficiency. Our goal is to improve this method by using multivariate analysis.

2.2 Multivariate analysis

On the contrary of the geometrical method which uses only one variable, we want to use many variables combined in multivariate analysis in order to enhance the purity, rate of well reconstructed events against bad, and efficiency, rate of well reconstructed events against events which can be reconstructed, of our sample. Variables implemented are angular parameters, reconstructed W boson mass and jets energies.

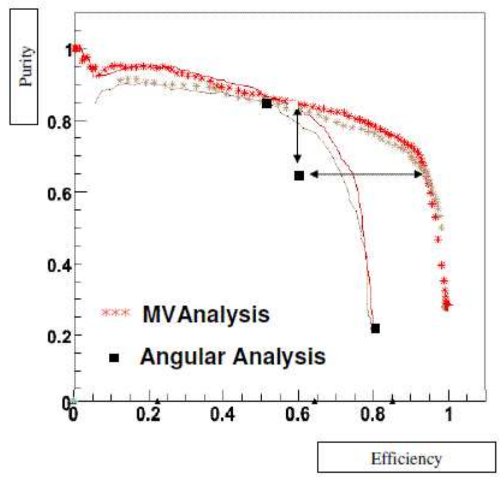

Figure 1: Purity of the sample versus the efficiency of the signal. Black squares show the results for geometrical jet selection. Lines represent the results for purification of the angular jet selected sample. Stars represent the results for MVA jet selection.

3 Conclusion and perspectives

On figure 1 we use multivariate analysis for the jet selection and see that we improve the efficiency greatly. This method allows us to gain 35% of well reconstructed top quarks compared to geometrical analysis giving us a powerful tool for top quark mass reconstruction. We expect that this method will lead to significant improvements on the top mass resolution.

References

1. G. Aad *et al.* [The ATLAS Collaboration] arXiv:0901.0512 [hep-ex].

[a] characterized by $\Delta R = \sqrt{\Delta\eta^2 + \Delta\phi^2}$ from the detector geometry where η is pseudo-rapidity and ϕ the angle between the transverse plan and the vertical to the beam axis.